
UNIVERSITY OF ALGARVE
Faculty of Sea and Environmental Sciences
MSc in Marine Biology
FISHERIES BIOLOGY
Exercises no. 4 (1st Year-1st Semester) **2007 / 2008**

MORPHOMETRIC LINEAR RELATIONSHIPS AND CONVERSION FACTORS

Consider the following morphometric data on total length and body height recorded for a certain species (data modified from Sparre & Venema, 1998). With this example we intend to demonstrate the estimation of morphometric relationships between two linear measurements (in this case, total length and body height)[1] taken from a fish species, using linear regression analysis.

Total length (cm)	Body height (cm)
11	3.3
12	3.9
14	4.0
16	4.8
17	5.2
18	5.5
19	5.7

1. Draw a dispersion plot (XY plot) of body height (YY axis) against total length (XX axis). Check that the relationship between the two variables is linear;

2. Estimate the parameters of the linear relationship between body height and total length (intercept and slope) by using the linear regression analysis[2] module in Excel[3].

3. Overlay the estimated linear relationship on the dispersion plot of observed values in the given example;

[1] Only a few pairs of values are used just for this exercise purpose. Normally, a large number of observations covering a wide range of total length values is used to estimate this type of relationships. Many other variables can be selected to obtain useful morphometric relationships, including measurements of fish processed onboard of commercial fishing vessels (beheaded fish length against total length, for example) – see, for example, http://www.fao.org/DOCREP/003/F0752E/F0752E03.htm#ac).

[2] Review your knowledgementAcknowledgements on "Linear Regression Analysis". I suggest to read section 2.4 of Sparre & Venema, 1998 ftp://ftp.fao.org/docrep/fao/w5449e/w5449e03.pdf (Biostatistics section) or in the Spanish versio http://www.fao.org/docrep/008/w5449s/w5449s00.htm and section 3.2 (pp 102-107) of King (1995), available for phottocopy.

[3] The access to the Excel regression module can be done through "Tools/Data Analysis/Regression", in the English version, or "Ferramentas/Análise de dados/Regressão", in the Portuguese version. If regression module is not installed you have to install it doing "Tools/Add-ins/Analysis ToolPak" (English version) or "Ferramentas/Suplementos/Análise de Dados" (Portuguese version).

4. Test the following null hypothesis: $H_{0:}$ a=0 (where a is the intercept of the linear relationship) at a significance level of 5% ($\alpha = 0.05$), by using the *t*-Student test. Use the output data produced by Excel Regression Analysis module;

5. If you do not reject the null hypothesis (*i.e.*, if, at 5% level of significance, the intercept cannot be considered statistically different from zero) re-estimate the linear relation parameters between body height and total length forcing the regression line to cross through zero (through the origin 0,0). The re-estimated slope or conversion factor can be used to convert from total length to body height. Use the option available for this case in the Excel regression analysis module.

LENGTH-WEIGHT RELATIONSHIP

Now let's estimate a relationship between weight and length, *i.e.*, the length-weight relationship[4], $W=q.L^b$ where W and L are, respectively, weight and length variables and *q* and *b* the model parameters, also known as the allometric condition factor and coefficient of allometry, respectively.

Consider a sample of 191 individuals (males and females combined) of the largemouth bass (*Micropterus salmoides salmoides*) captured in the lake Khale, Pennsylvania, United States of America (computer file "BP0708_Ficha04_data.xls", for downloading); the data recorded was weight (g) and total length (mm).

6. Draw in a dispersion plot the weight (YY axis) against length (XX axis). Check that the relationship between the two variables is not linear; instead it can be better described by a power function.

7. Using the data available, estimate, a length-weight relationship for the largemouth bass of lake Khale, Pennsylvania, United States of America. Estimate the length-weight relationship parameters by linear regression. To do so, proceed as follows:

   a. Log transform the weight and length data using natural logarithms (base e);

   b. Plot ln (weight) values against ln (length) and observe the relationship obtained using the log transformed data;

   c. Regress ln (weight) on ln (length) and calculate the regression line parameters (intercept and slope). Use the regression analysis module in Excel to perform this exercise;

   d. Calculate the anti-log of the intercept to obtain the allometric condition factor;

   e. Overlay the estimated length-weight relationship curve on the weight-length dispersion plot. Start your graph from the origin (0,0).

[4] Read section 2.6 of Sparre & Venema, 1998 ftp://ftp.fao.org/docrep/fao/008/w5449p/W5449p03.pdf (or http://www.fao.org/docrep/008/w5449s/w5449s00.htm, in Spanish) and read section 3.2 (pp 107-111) of King (1995), available to photocopy (please ask me for information). These two references give you a good perspective on these subjects, helping you to understand the estimation process used for length-weight relationships.

NB: If grouped data was available (frequencies of mean weight by length class data) you should use mean length values and the pair of observations should be weighed using the frequencies.

Recommended literature:

1. **Brown, M.L. & D.J. Austen, 1996**. Data management and statistical techniques. *In*: Murphy, B.R & D.W. Willis (eds). Fisheries techniques. 2nd edition. American Fish Society, Maryland, pp: 17-62

2. **King, M., 1995 -** Fisheries Biology, Assessment and Management. Fishing News Books, Oxford, pp: 102-111

3. **Sparre, P. & S. C. Venema, 1998** - Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fisheries Technical Paper Nº 306.1. Rev. 2. Rome, FAO, 407 p. http://www.fao.org/docrep/W5449E/w5449e00.htm

Sparre, P. & S. C. Venema, 1999. Introduction to tropical fish stock assessment. Part 2. Exercises. FAO Fisheries Technical Paper. No. 306.2, Rev. 2. Rome, FAO. 1999. 94 p. http://www.fao.org/docrep/W5448E/W5448E00.htm

Spanish version**:**

Sparre, P. & S. C. Venema, 1997. Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fisheries Technical Paper. Nº. 306.1, Rev. 2. Rome. http://www.fao.org/docrep/008/w5449s/w5449s00.htm

Sparre, P. & S. C. Venema, 1997. Introduction to tropical fish stock assessment. Part 2. Ejercicios. FAO Fisheries Technical Paper. N° 306.2, Rev. 2. Rome. http://www.fao.org/docrep/W5448S/W5448S00.htm

4. **Holden, M. J. & D. F. S. Raitt, 1974** - Manuel de Science Halieutique. Deuxiéme partie - Méthodes de Recherches sur les Ressources et leur Application. Doc. Tech. FAO Pêches (115) Rev. 1: 223p. **(French version)**. Available at the University library and *online*: http://www.fao.org/DOCREP/003/F0752F/F0752F00.HTM

English version: Manual of Fisheries Science. Part 2 - Methods of Resource Investigation and their Application. Only available *online*: http://www.fao.org/DOCREP/003/F0752E/F0752E00.HTM

Spanish version**:** Manual de Ciencia Pesquera. Parte 2 - Métodos para Investigar los Recursos y su Aplicación. Only available *online*: http://www.fao.org/DOCREP/003/F0752S/F0752S00.HTM

5. **Zar, J.H., 1999.** Biostatistical analysis. 4th edition. Prentice-Hall Inc, New Jersey, 929 p. (or any other statistical book that includes a topic on regression analysis).